REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. AGENCY USE ONLY *(LEAVE BLANK)*	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED
	4 June 1999	Professional Paper

4. TITLE AND SUBTITLE

Design and Test of the Combat Rubber Raiding Craft

5. FUNDING NUMBERS

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7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)

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8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)

Naval Air Systems Command
47123 Buse Road, Unit IPT
Patuxent River, Maryland 20670-1547

10. SPONSORING/MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION/AVAILABILITY STATEMENT

Approved for public release; distribution is unlimited.

12b. DISTRIBUTION CODE

13. ABSTRACT *(Maximum 200 words)*

The U.S. Navy H-60 Seahawk aircraft is routinely used in support of the Special Warfare community. In particular, operational squadrons are frequently tasked to insert SEAL personnel and equipment into hostile areas. For over-water missions, equipment to be carried and deployed includes weapons, ammunition, and the Combat Rubber Raiding Craft (CRRC). The CRRC is a specially fabricated inflatable raft measuring 15'5" by 6'3" and weighing up to 2,866 lb fully loaded. The CRRC contains eight airtight compartments and is designed to be operated by a crew of up to eight personnel using an outboard engine with a maximum rating of 65 Hp. The previous method for deploying the SEAL team, CRRC, and the equipment involved lowering personnel, the deflated CRRC and remaining equipment separately to the water via the rescue hoist, where the CRRC was subsequently inflated and loaded for the mission. NAWCAD engineers in conjunction with engineers from SEAL Team Training Group Two proposed and investigated several options for external carriage of the CRRC. One option involved fabrication of a Cargo Hook Restraint System (CHRS) that was attached to a single point on the aircraft via the aircraft cargo hook. The HH-60H platform team led the effort to design, fabricate, structurally analyze, and develop an operational flight envelope and deployment methods of this configuration. Successful completion of tests has resulted in providing an operational capability to the fleet operators, allowing deployment of the Special Warfare personnel, with a fully loaded CRRC, in approximately 30 sec vice the previous 30 min.

14. SUBJECT TERMS

H-60 Seahawk
Combat Rubber Raiding Craft (CRRC) Cargo Hook Restraint System (CHRS)
Night Vision Goggle (NVG) High Light Level (HLL) Low Light Level (LLL)
Special Warfare Support (SWS) Special Operations (Spec Ops)

15. NUMBER OF PAGES

11

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
Unclassified	Unclassified	Unclassified	UL

DESIGN AND TEST OF THE COMBAT RUBBER RAIDING CRAFT

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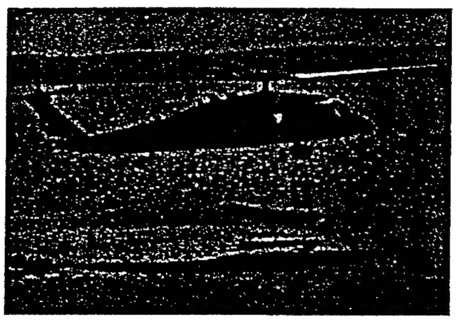
ABSTRACT



The United States Navy H-60 Seahawk aircraft is routinely utilized in support of the Special Warfare community. In particular, operational squadrons are frequently tasked to insert SEAL personnel and equipment into hostile areas. For over-water missions, equipment to be carried and deployed includes weapons, ammunition and the Combat Rubber Raiding Craft (CRRC). The CRRC is a specially fabricated inflatable raft measuring 15'5" by 6'3" and weighing up to 2866 lbs. fully loaded. The CRRC contains eight airtight compartments and is designed to be operated by a crew of up to eight personnel utilizing an outboard engine with a maximum rating of 65 Hp. The previous method for deploying the SEAL team, CRRC, and the equipment involved lowering personnel, the deflated CRRC and remaining equipment separately to the water via the rescue hoist, where the CRRC was subsequently inflated and loaded for the mission. Engineers at Naval Air Warfare Center Aircraft Division (NAWCAD), in conjunction with engineers from SEAL Team Training Group Two proposed and investigated several options for external carriage of the CRRC. One option involved fabrication of a Cargo Hook Restraint System (CHRS) that was attached to a single point on the aircraft via the aircraft cargo hook. The CHRS design includes an I-beam cargo hook adapter restraint attached to the flexible aluminum floor of the CRRC and fixed tie down points. The HH-60H Platform Team at Naval Rotary Wing Test Squadron (NRWATS) led the effort to design, fabricate, structurally analyze, and develop an operational flight envelope and deployment methods of this configuration. The flight test involved airworthiness qualification, including captive carriage and jettison envelope development, and shipboard envelope expansion. Additional tests involved development of deployment and recovery procedures including night over-water releases from 10' AGL. Final tests included deploying and recovering actual SEAL Team members under operational conditions in order to verify the configuration and procedures. Numerous technical challenges, including aerodynamic effects, center-of-gravity effects, structural loading effects and modification of normal flying qualities, were overcome during the course of the evaluation. Successful completion of these tests has resulted in providing an operational capability to the fleet operators, which allows deployment of the Special

Warfare personnel, with a fully loaded CRRC, in approximately 30 seconds vice the previous 30 minutes.

ACRONYMS, ABBREVIATIONS, AND SYMBOLS

CRRC – Combat Rubber Raiding Craft (Zodiac F470 Series)

Spec Ops – Special Operations

CHRS – Cargo Hook Restraint System

NVG - Night Vision Goggles

HLL – High Light Level

LLL – Low Light Level

SWS – Special Warfare Support

INTRODUCTION

The United States Navy Special Warfare Support (SWS) mission requires the deployment of the Naval Special Operations personnel from H-60H/F using the CRRC. The previous deployment method required the CRRC to be rolled and deflated and placed in the cabin with the support equipment and special operations personnel reducing the available cabin area. Deploying the CRRC from the HH-60H in a deflated rolled configuration required the helicopter to spend excessive time in a hover to unload all the required equipment and Special Warfare personnel. The US Navy method used was referred to as the tethered duck insertion method. The United States Air Force and United States Army developed alternative methods of deploying the CRRC by lashing it to the underside of the aircraft using a cargo net and securing it in the cabin area using CGU1B cargo straps. Deployment required cutting the cargo straps to release the CRRC. Both methods had the CRRC fully inflated but with no gear placed within the interior of the CRRC. In addition the both method required the aircraft to land on the CRRC in order to install it. The Air Force and Army methods would not readily work for the Navy, primarily because landing on the CRRC on a moving ship deck was determined to be a potential flight hazard and would require an excessive amount of time to complete the installation. The CRRC Cargo Hook Restraint System (CHRS) was designed to allow the required operational equipment to be placed in the CRRC, removing both raft and equipment from the cabin area. The specially developed CRRC CHRS is designed to attach a fully equipped and fully inflated CRRC to the aircraft via the cargo hook. The single point attachment point would provide a simple release of the CRRC for deployment and/or emergency jettison.

PROJECT GOALS

The primary objective of the program was to devise a method for external carriage of the CRRC without making any permanent modification to the aircraft, this limited the design choices by the team. In addition, the external carriage of the CRRC was to have no noticeable degradation on the aircraft handling qualities or performance. The secondary objectives were to evaluate and define the following:

(1) Shore-based and ship-based CRRC loading procedures.

(2) Aircraft flying qualities with CRRC installed.

(3) Aircraft operational flight envelope with CRRC installed.

(4) CRRC emergency jettison envelope.

(5) CRRC sling load flight envelope and recovery procedures.

(6) Operational NVG flight envelope and deployment procedures for CRRC Cargo Hook Restraint System.

The final objective was to obtain a fleet-wide flight clearance for use of the system at the completion of testing.

CRRC CHARACTERISTICS

<u>CRRC ZODIAC RAFT - F470</u>

The CRRC Zodiac raft is a Special Warfare inflatable raft constructed from Hypalon Neoprene-coated 1880 Decitex fabrics manufactured by Zodiac of North America, Incorporated. The CRRC is the F470 series inflatable raft that is approximately 15'5''in length with an overall width of approximately 6'3''. The CRRC Zodiac raft weight without aluminum floorboards is 265 lbs. with aluminum floorboards is approximately 355 lbs. The flooring is designed to be an interchangeable system with aluminum slats in a durable anti-wear fabric, roll out pattern, designed for ease of installation and removal, along with providing rigidity to the craft. The CRRC Zodiac is designed for 6 to 8 personnel and equipment with a combined maximum operational weight of 2866 lbs. The CRRC Zodiac is designed with eight airtight compartments with five inflation valves that can be inflated either by compressed air or by a foot bellows air pump. The basic CRRC zodiac is designed with overpressure valves to ensure proper inflation pressure and reduce possibility of over inflation. The CRRC Zodiac is designed to operated with a 40 HP engine but is capable of handling up to a maximum 65 HP engine with the aluminum deck installed.

FLIGHT CLEARANCE REQUIREMENTS

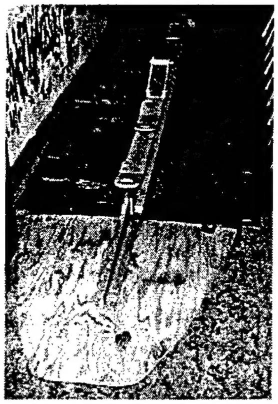
The first requirement was that the CRRC be installed in a safe manner on land and aboard ship. Since the Air Force and Army methods of landing on the CRRC to install it would not work on-board ship for the Navy, a method had to be devised that would be effective both on land and at sea. The second requirement was that the device to be used as the attachment hardware for the CRRC and aircraft installation is structurally sound and meets the requirements of reference (a). The third requirement was that the CRRC, aircraft and ground interaction would have no effect on the aircraft ground resonance characteristics. The potential for changes in the aircraft ground resonance characteristics existed with the CRRC installed and fully inflated. There was no clearance between the aircraft and the ground with the CRRC installed and the potential for the CRRC to offload the landing gear existed. The fourth requirement was that there could be no adverse affect on the aircraft aerodynamic characteristics with the CRRC installed or during emergency jettison.

TECHNICAL CHALLENGES

The test team undertook three major technical challenges. The first was to design the restraint system that would be used to secure the CRRC to the aircraft. As had been stated earlier in the paper there could be no modifications made to the aircraft. The attaching mechanism was required to have a single point release that would be used for both mission deployment and emergency jettison. The attaching mechanism was designed to support the SWS mission equipment up to 1200 lb. In addition the attachment mechanism had to meet US Navy crash criteria, reference (a). The second was a loading mechanism that would allow for ease of installing a fully loaded CRRC onto the aircraft for land and sea based missions. As discussed earlier, the previous methods for attachment were to land on the CRRC and strap it to the aircraft. Furthermore, this method required the aircraft to make repeated landings in order to properly secure the CRRC tightly to the bottom of the aircraft. In addition, the device had to be able to traverse ships decks without becoming stuck on tie down rings or fuel dams. The loading had to be accomplished relatively quickly to support operation tempo on-board ship. The third challenge was to devise a method to recover the CRRC for the emergency jettison test. Due to fiscal restraints in the program the team was limited to two CRRC's for the start of the program one primary and one backup. Finally a method had to be devised to recover the CRRC and SPEC OPS personnel after completion of the exercise mission. Considerable logistic support was required to return the SPEC OPS personnel and equipment back to the ship after completion of the exercise.

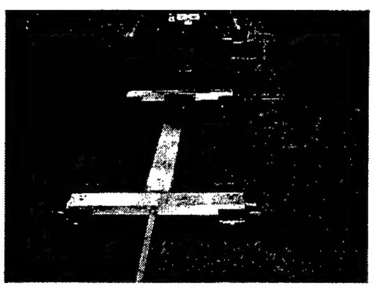
TECHNICAL SOLUTIONS:

CRRC CARGO HOOK RESTRAINT SYSTEM



The CRRC Cargo Hook Restraint System (CHRS) was designed to be attached to the CRRC via the aluminum floorboards, the raft transom, and the fixed forward wooden floorboard. The CHRS was constructed of a single I-Beam and cargo hook adapter lug made of 2024 T_4 aluminum. The I-Beam was approximately 105 inches long and was located in the geometric center of the CRRC running lengthwise bow to stern. Along the length of the I-Beam were various attachment rings to allow for cargo tie down points and to allow for attachment of tie lines to the bow rings located on the CRRC. The cargo hook adapter lug was fabricated using 3/8 inch 2024 T4 aluminum side plates, 2 1/2 inch 2024 T4 aluminum channel section and a 1-1/2 inch steel spacer. The cargo hook adapter was mounted on the I-Beam approximately 40 inches from the aft end of CRRC. The cargo hook adapter was designed to be attached to the aircraft cargo hook. This system was designed with a single release point (cargo hook) to allow for ease of insertion and for emergency jettison.

CRRC ZODIAC JACK



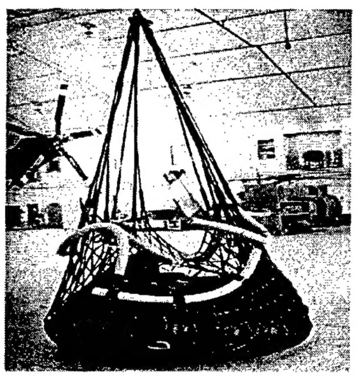
Shore-based and sea-based loading procedures using the CRRC Zodiac jack were developed on land before being evaluated at sea. The evaluation was conducted aboard two classes of ships in the Navy inventory. The procedures for loading the CRRC are as follows. The aircraft main landing gear struts were serviced in accordance with aircraft maintenance instructions prior to loading the CRRC and X-dimensions were recorded. A ballasted and partially inflated CRRC was placed on the jack and was positioned in front of the aircraft. The forward screw jack on the Zodiac jack was partially extended (3 to 4 inches) to facilitate the loading sequence. The aircraft main landing gear struts were service to maximum allowable extension. The CRRC was positioned under the aircraft using the zodiac jack, lining up the CHRS lift lug with the aircraft cargo hook. Once the CRRC was in position the CRRC was jacked up using the zodiac jack to connect the lift lug with the cargo hook. The zodiac jack was lowered back to its original position and removed from under the CRRC/aircraft. The main landing gear struts were deserviced and returned to the original X-dimension and the CRRC was fully inflated. The seal between the CRRC and the aircraft fuselage was inspected to ensure that the CRRC was properly seated prior to flight. The entire evolution required 10 to 15 minutes to complete.

PARACHUTE RECOVERY SYSTEM

The undamaged recovery of the CRRC for the emergency jettison portion of the test was paramount for the team. The jettison-testing envelope consisted of drop 18 test points. In

order to minimize the number of CRRC's required for this testing a method for recovery was devised to help limit the number of CRRC's required for the test. The method chosen was to use a G-14 cargo parachute to aid in the recovery of the CRRC. The parachute recovery system consisted of one G-14 cargo parachute assembled in a flat pack configuration located in the aft portion of the CRRC next to the transom. The parachute risers were attached to the CRRC via two cargo rings located on the outer part of the transom. The parachute static line was attached to the cargo hook beam on the aircraft using gutted 550-parachute chord. When the CRRC is jettisoned, the 15-ft. static line breaks the 80-lb. tie line, which releases the G-14 parachute. As the parachute deploys the static line breaks free of the aircraft at the 550-parachute chord tie point leaving only a four or five-foot piece of 550-parachute chord attached to the cargo hook beam. Prior to the parachute fully deploying, the CRRC was in a nose down attitude allowing the sandbag ballast to depart the CRRC, further reducing the parachute opening shock effects on the CRRC. A range safety boat recovered the CRRC and G-14 parachute.

CARGO NET\CRRC



The method devised to recover the CRRC and SPEC OPS personnel after completion of the exercise mission was to use a 10,000-lb. cargo net fitted with color-coded floatation. The 10,000-lb. capacity octagon-shaped cargo net is constructed from interwoven nylon cord. Each set of four lifting legs has a hook that attaches to the apex fitting that was connected to the aircraft cargo hook via cargo line and pendent. The apex fitting was attached by tether cord to the set of lifting legs with the net identification tag. The other ends of the lifting legs were attached to the net's outer border cord. A square shaped load zone was marked by yellow cord interlaced with the net mesh. This zone marks the center of the net and was used as a guide to place the load. When positioning the load the sides of the load can extend beyond the load zone, but the overhang should be same on both sides. The 10,000-lb. capacity cargo net was black and the body of the net was 18 ft wide. It is constructed from heavy weave nylon braided cord with 7-1/2 inches between mesh. The net weighs 96 lb. and has a volume capacity of 380 cubic feet. Color-coded floatation was added to supply the net with some positive buoyancy to aid the in-water recovery and help aid in positioning the net around the CRRC. The Spec Ops equipment was secured inside the CRRC that was secured inside the cargo net. The net was attached to the aircraft via the cargo hook using a 60-ft pendant and 10,000 lb. locking carabiners. The 60-Ft pendant was utilized to minimize the downwash effects on the Spec Ops personnel during the recovery.

ENGINEERING FLIGHT TEST RESULTS

CAPTIVE CARRIAGE TEST RESULTS

Mechanical rev-up test (ground resonance) was performed to determine if the CRRC would cause any changes in the aircraft ground resonance characteristics. The

CRRC was placed underneath the aircraft at various inflation states to fully inflated and the cyclic was stirred in a counterclockwise 3 in. diameter circle at 1, 2, and 3 Hz frequencies. The results of the mechanical rev-up test showed no indication that the CRRC was altering or inducing any ground resonance problems. Airspeed, angle of bank, and climbs and descents sweeps tests were performed using trimmed flight control test techniques to determine the CRRC installed flight envelope. The CRRC equipped aircraft was cleared to a maximum forward airspeed of 144 KIAS and maximum bank angle was cleared to 45 degrees both left and right. Climbs and descents were cleared to the basic limits of the airframe. Handling Qualities, Steady Heading Sideslips, lateral directional stability, critical azimuth, and low airspeed tests were performed to determine if the installed CRRC would cause any detrimental effects on the aircraft handling qualities. No test indicated an adverse effects on either the aircraft handling qualities or performance. Captive carriage tests defined the operational flight envelope for the aircraft operating with the CRRC installed. Further the aircraft in-flight operating limits were the same as current NATOPS, Run on landings, running takeoffs and hover landings are prohibited with the CRRC installed.

JETTISON TEST RESULTS

The CRRC in-flight emergency jettison envelope was evaluated at NAWCAD test range. The aircraft was stabilized on heading, altitude, and airspeed prior to CRRC jettison. The CRRC was jettisoned using the copilot cargo release button located on the cyclic control grip. The recovery of the CRRC was aided by the use of the G-14 parachute attached to the CRRC transom. The CRRC separation characteristics from the aircraft were clean with only a slight jump felt in the aircraft for airspeeds from 20 to 100 KIAS and noticeable jolt at 120 and 140 KIAS. The jolt, though noticeable to the pilot, did not pose any hazard to the aircraft or aircrew and was not uncomfortable. The CRRC fell away from the aircraft in an upright, flat attitude and was clear of the aircraft prior to entering the slipstream. As the CRRC entered the slipstream, the nose of the CRRC, depending on aircraft pitch attitude, pitched nose up for airspeeds of 20, 40, 60, and 80 KIAS and pitched nose down for airspeeds of 100, 120, and 140 KIAS.

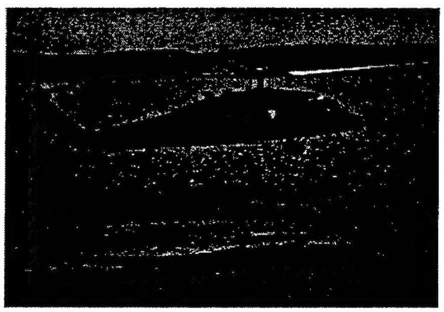
MISSION REPRESENTATIVE TESTS

SHIPBOARD RESULTS

The CRRC flight operations were conducted aboard the USS JOHN L. HALL and included day VMC launch and recovery comparative flights only. The flights evaluated the effects of the installed CRRC and the effects on the relative Wind Over Deck (WOD) for the H-60/FFG-7 day wind envelope. The aircraft with CRRC installed was evaluated in relative WOD up to a maximum of 45 kt bow wind, 20 kt, port wind, 20 kt starboard wind and

10 kt tailwind. The pilots noted no anomalous behavior for any flight conditions. The shipboard observers noted no tendency for the CRRC to sway or move during shipboard operations launch and recoveries. Three CRRC releases were conducted on the ship flight deck. The CRRC was released on deck from a low hover over the deck (tailwheel touching deck). Once the CRRC was on deck, the aircraft departed the flight deck area and entered a starboard delta pattern. The deck personnel had no difficulty in removing the CRRC from the deck vicinity prior to aircraft landing. Approximately 8 to 10 personnel gripped the fully loaded and inflated CRRC by the CRRC handholds and lifted the CRRC on to the zodiac jack. The CRRC was pulled into the hangar using the zodiac jack. The CRRC did not show any abrasions or wear due to being dropped on the ship's flight deck. The carriage of the CRRC did not significantly impact the aircraft's flying qualities or performance during shipboard operations. Comparison of land based and shipboard H-60 CRRC flying qualities with non CRRC flying qualities data revealed no handling qualities anomalies attributed to the carriage of the CRRC.

DAY MISSION RESULTS



CRRC simulated mission deployments were evaluated under daylight conditions, in light winds (6 kt). The AFCS was engaged and the CRRC was ballasted with special operations equipment and installed on the aircraft cargo hook. The crew consisted of a pilot, copilot, one aircrewman, one cast master, and 4 special operations personnel. Five buildup modified automatic over-water-approaches were completed prior to simulated mission release to develop the timing and insertion coordination. The non-flying pilot using the cargo hook release switch located on the cyclic control grip, once the aircraft was established at 10 ft/10 KGS following a modified automatic approach, released the CRRC. The special operations personnel deployed from the aircraft, one at a time, after the CRRC was released and clear of the aircraft. After all of the special operations personnel exited the aircraft, the aircrewman report "Last man out" to the pilots. The aircrewman observed that all the special operations personnel were okay as was indicated by the swimmer's "thumbs up" signal. Upon notification to the pilots that all special operations personnel were safe, the aircraft departed from 10-ft AGL/10 KGS forward creep and climbed to 150 ft AGL and 60 KIAS. There were no noticeable increases in aircraft altitude with the deployment of the CRRC or special operations personnel. Once 10 ft/10 KGS forward creep was established, the sequence of CRRC release and special operations personnel insertion/deployment required 15 seconds on the first run and was reduced to 10 seconds on the second run. The daytime procedure was safe, smooth and easily performed. The CRRC remained upright and stable when released from 10 ft/10 KGS contacting the water with a slight nose up attitude. Deployment of the CRRC during simulated special operations missions verified the time required to complete the mission would be significantly reduced, minimizing aircraft/aircrew exposure to hostile fire.

NIGHT MISSION RESULTS

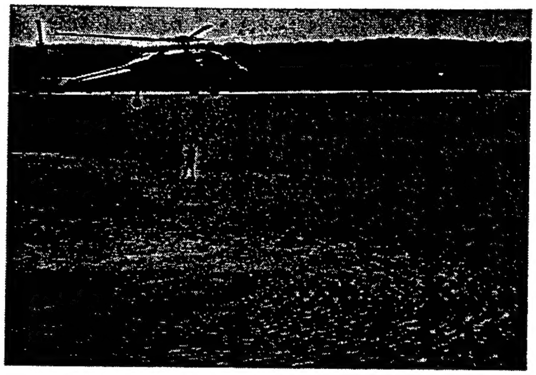
HLL DEPLOYMENTS

CRRC deployment was evaluated at night under HLL conditions, using ANVIS-6 NVG's and the modified automatic over-water-approach profile down to 10 ft/10 KGS forward drift. The winds were calm and the sea state zero (unreliable Doppler return). The entry altitude and airspeed were 150 ft AGL and 90 KIAS. During the modified automatic over-water-approach, the Doppler was in and out of memory, requiring the pilot to conduct a degraded modified approach (the pilot set the pitch attitude to 10 degrees nose-up until a reliable Doppler return was acquired). During the degraded approach, once the aircraft was established at 40 ft AGL, the rotor downwash generated sufficient water turbulence to provide reliable Doppler return. Following the completion of the degraded approach to 40 ft AGL a 10 KGS forward drift was maintained by the pilot until the Doppler acquired, allowing AFCS to maintain the 10 KGS forward drift. The aircraft was not dialed down to 10 ft/10 KGS until a reliable Doppler return was received and AFCS indicated a latched approach to 40 ft/10 KGS forward drift. The left seat pilot dialed the aircraft down to 10 ft AGL in 10 ft increments. The salt spray and water buildup on the windscreen and aircraft were noticeable but did not significantly degrade the NVG performance. The salt spray did reduce the clarity of the horizon. After the aircraft was stabilized at the 10 ft/10 KGS forward drift, the CRRC was deployed using previously established procedures. The CRRC was successfully deployed during the simulated night HLL special operations mission.

LLL DEPLOYMENTS

CRRC deployment was evaluated at night under LLL conditions, using ANVIS-6 NVGs and the modified automatic over-water-approach profile down to 10 Ft/10 KGS forward drift. The winds were 12 to 18 kt and the sea state was one (reliable Doppler return). The entry altitude and airspeed were 150 ft AGL and 90 KIAS. The AFCS pots had no freeplay. For the modified automatic over-water-approach, the AFCS control pots were set for 40 ft AGL and 10 KGS forward drift. Once the AFCS indicated a steady RADALT and HVR mode on the AFCS control panel at 40 ft AGL and 10 KGS, the left seat pilot dialed the AFCS altitude control pot down in 10 ft increments until the aircraft was established at 10 ft/10 KGS forward drift. During the approach, salt spray buildup on the windscreen effected the Field of View (FOV) requiring the left seat pilot to turn on the windshield wipers when the aircraft was steady at 20 ft AGL altitude. The windshield wipers remained on for the completion of the deployment and were secured during the departure. The CRRC was deployed using previously established procedures. The salt spray and water buildup on the windscreen and aircraft were noticeable but did not significantly degrade the NVG performance.

RETRIEVAL RESULTS



The CRRC in-water recovery, using 10,000-lb. octagon shaped cargo net and 60 ft sling/pendent, was conducted over water, near NAS Patuxent River West Sea Plane Basin. The ballasted CRRC, with special operations personnel onboard, was towed by Rescue/Safety chase boat to over-water operational area. The test aircraft was rigged with the 60 ft sling/pendent attached to the aircraft cargo hook with the sling/pendent stored in the cabin area. The test aircraft executed an approach to a 60 ft AGL hover near the CRRC. The aircrew lowered the cargo net, via the rescue hoist, to the special operations personnel in the water. The special operations personnel unhooked the cargo net and then rigged the cargo net around the CRRC using the previously established. The aircraft positioned approximately 50 yards from the CRRC while the special operations personnel attached the cargo net around the CRRC. Once the special operations personnel signaled the aircraft that the attachment was complete, the aircraft repositioned back toward the CRRC. Two of the four special operations personnel were recovered into the aircraft via the rescue hoist. The aircraft repositioned away from the CRRC and remaining special operations personnel (approximately 50 yards) and the aircrewman lowered the cargo sling/pendent from the cabin area (hand over hand) until the sling/pendent was in the water. The aircraft repositioned over the CRRC dragging the sling/pendent in the water. The special operations personnel retrieved the sling/pendent and attached it to the cargo net using the 10,000-lb. carabiners. The remaining two special operations personnel were then recovered into the aircraft via the rescue hoist. During the special operations personnel hoist recovery the special operations personnel contacted the sling/pendent during the ascent to the aircraft. Operation of the rescue hoist was halted until special operations personnel were clear of the sling/pendent. The special operations personnel were then safely recovered onboard the aircraft. The CRRC/cargo net were then lifted vertically out of the water and the aircraft began a vertical climb to increase the CRRC/cargo net clearance from the water. Once the CRRC/cargo net was sufficiently clear of the water, the aircraft transitioned to forward flight and returned to base. When positioning over the CRRC (for pendent hook up to cargo net around CRRC), the aircraft must be positioned quickly or rotor downwash will push the CRRC/Cargo net away from the aircraft. The total time for the recovery evolution was 30 minutes.

LESSONS LEARNED

Ballasting the CRRC to represent mission gross weights was accomplished by using 50 lb sandbags. Problems with the CRRC being seated correctly on the aircraft were a result of an unbalanced load distribution in the CRRC. It was discovered during the hover check prior to flight that the CRRC was moving underneath the aircraft. Two factors played into the movement of the CRRC. The first was the sandbag ballast was unevenly distributed in the CRRC causing an extreme nose up attitude. The second was that when securing the

load inside the CRRC, the tubular nylon tie straps were not properly tightened. This resulted in the CRRC flexing away from the aircraft. In order to correct the problem, a method was devised to insure that the load was properly balanced and secured. Determination of the CRRC CG was accomplished using an overhead hoist. Ballast/special operations equipment was arranged to have the CG centered at the CHRS lift lug. Sandbag ballast/special operations equipment was secured inside the CRRC using 1/2 to 1-inch tubular nylon attached from the CHRS to the CRRC rings. Proper CG location (lift lug) and CRRC tie down procedures were required to insure CRRC/aircraft safe operations. Incorrect tie down procedures and improper CRRC CG position would lead to CRRC movement under the aircraft resulting in CRRC failure.

CONCLUSIONS

The test program was very successful in developing and certifying the captive carriage method of the CRRC for the SWS mission. The program was completed on time and on budget providing the Navy with an unique in-house solution to its CRRC SWS operations. The test program had successfully defined the installed CRRC flight envelope, emergency jettison envelope, night and day insertion procedures, land and shipboard loading procedures and the recovery procedures. The test program met the primary test objectives of not modifying the aircraft for CRRC installation and the CRRC having little or no effect on the aircraft's handling qualities. The test report was published a head of schedule. The fleet has finished initial training and validation and verification of the procedures for inserting the CRRC using the CHRS. The CHRS is now presently being used by the fleet in support of SWS mission.

REFERENCES

a. Military Standard for the Certification of Externally Transported Military Equipment By Department of Defense Rotary Wing Aircraft, MIL-STD-913, 3 January 1991.